INDIAN TEA ASSOCIATION

SCIENTIFIC DEPARTMENT

TOCKLAI EXPERIMENTAL STATION

ANNUAL REPORT—1938

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The health of the staff throughout the year has been normal.

Staff.—Messrs. P. H. Carpenter and S. F. Benton were on home-leave during the year.

Mr. L. C. Conrie joined the Department as Entomologist on the 27th October.

Messrs. F. S. Mitchell, E. J. Winter and Dr. E. K. Woodford joined the Department as District Advisory Officers and arrived at Tocklai at the end of October.

Buildings.—The various buildings were maintained in a proper state of repairs.

Tea area.—82.5 acres.

Touring.—With the appointment of Dr. E. A. H. Roberts on the Chemical staff it has been found possible to resume a normal system of touring. The following districts were visited during the year:—

Ceylon, Dibrugarh and Panitola, Western Dooars, Chatla Bheel, Lakhipur, Balisera, Luskerpore, North Sylhet, Tezpur, Bishnauth and Boroi.

Correspondence.—During the year 4,926 letters were received by the Department and 5,835 letters were despatched.

The total number of samples and specimens received during the year were—

Specimens ...	Chemical Branch	...	1,296
	Entomological Branch	...	111
	Mycological Branch	...	1,430
	Bacteriological Branch	...	31
	Botanical Branch	...	26
		Total ...	2,894

Lecture Courses.—Three series of Lecture Courses were held during the period 21st November to 10th December, 1938.

Annual Conference.—The Second Annual Conference was held on the 17th, 18th and 19th February, 1938.

Visitors.—There were 226 visitors to the Station. His Excellency Sir Robert Reid and Lady Reid visited the Station in February. The Chairman of the Indian Tea Association, London, Mr. A. N. Stuart visited the Station during December.

Field Experiments.—The Field experiments have been continued at Tocklai and Tulsipara. On 32 tea estates manuring experiments are now being carried out with the co-operation of the Department.

With the continuation of the Tea Control Act and the consequent limitation in crop production, the more particular interest lies :—

(*a*). In the replacement of old debilitated tea by new bushes which will have greater cropping capacity;

(*b*). Upon the improvement that may be made in the quality of the tea by making the best of the leaf that is available;

(*c*). In trying to obtain bushes that are capable of giving better tea.

The work at Tocklai during the past year has contributed some additional knowledge to these three lines of research.

Young Tea.—Many gardens are uprooting old tea and are having to replant the same area since the Control Act does not permit of replacing the uprooted tea by tea on a new area. This results in the new tea being planted upon land that is often down to a basic level of production and is capable of giving no more than about 5 mds. per acre of tea. Such land is poor and for the new tea to develop satisfactorily and in an economic manner manuring of the young tea is necessary. The land at Borbhetta is capable of giving about 5 mds. of tea per acre per annum if unmanured and consequently affords an opportunity of an experiment dealing with the manurial treatment of tea from the commencement of planting with 12-months old plants. The results provide a useful guide for garden replanting practice. The experimental results shew that the use of potash has been beneficial and the more potash used the better the results within the limits of the experiment. This is shewn in the greater weight of prunings and in the greater crop of leaf plucked in the second and third years from seed.

The value of an application of readily available nitrogen is also demonstrated but it is also evident that in the first year in the field the young plants can easily be damaged by an overdose, tea receiving an application of 20 lbs. nitrogen per acre having grown better than tea receiving 60 lbs. of nitrogen.

The use of phosphate has made apparently no difference to the development of the bushes but it has given a significant resistance to red spider attack and for this reason its use can be justified

Appendix I is a detailed note of recommendations for the treatment of replanted young tea based on the results of the experiment at Borbhetta.

Pruning.—The initial pruning of young tea at different heights from the ground is also under experiment. It will

however be some years before any final conclusion can be drawn since liability to disease and the suitability for cutting back need to be considered. So far the experiment shews the disadvantage of cutting to only 2" above the collar compared with cutting at 8"—10" and 16"—18" both in deaths immediately following cutting and in the crop obtained during the early years. In 1938 three years from seed the crops from the 8"—10" and 16"—18" cutting are not significantly different.

Considerable progress is being made in the examination of the tea made from individual bushes with the object of obtaining vegetative reproduction from selected bushes.

During the year some 90,000 cuttings have been taken from selected bushes covering 27 *jats* of which some 26,000 are still alive. There is a noticeable variation in the ease of rooting of cuttings from different bushes. Considerably more work will have to be done before a satisfactory technique is evolved but some progress has been made in establishing small clones that are in regular plucking and can be used for further experiment.

Whilst it is possible to raise bushes from cuttings it will not be suitable to grow as a seedbari bushes raised from cuttings from the same bush, for the tea plant shows an appreciable degree of self-sterility and invariably sets a better crop of seed with pollen from another bush. It will consequently be necessary to have bushes from at least two independent sources in the seedbari in order to obtain a satisfactory crop. Considering any seedbearer it is always possible to find a source of pollen which if this alone is caused to fertilise the flowers of the seedbearer will result in an outstandingly good crop of seed; use of the best pollinator on an average will result in twice as much seed as would be set if the seedbearer had been supplied with a total equal amount of pollen but supplied from all the bushes in the neighbourhood. In particular cases nearly four times the crop has been obtained.

The average crop of seed set by a tea bush with its own pollen is about ¼ of what would be set if the flowers are able

to receive adequate supplies of pollen from numerous other bushes. It has been found possible for artificial self-pollination to give as big a crop of seed as that resulting from natural pollination under conditions where it is evident that insects do not provide an efficient cross-transfer of pollination. A complete cross-transfer of pollination by artificial means has been shown to result in 13% of flowers setting seed or something in the order of six times the seed crop usually obtained in a tea seed garden under Upper Assam conditions. This result is similar to that obtained by Wellenseik in Java.

The Russian Botanists have found that plants resulting from self-pollination were inferior in vigour to those resulting from cross-pollination beside which the self-fertilised seed showed a marked reduction in germinating capacity.

Manuring: *Autumn vs. Spring.*—At the present time much attention is being paid to distributing the annual tea crop so as to obtain a maximum amount of tea during the second flush and autumnal periods when the best quality tea is being made. With this object in view some gardens have adopted a system of manuring in the autumn. Experiments at Tocklai indicate that this results in only a small increase of crop at the end of the one season and beginning of the following season. The manufacturing experiments at Tocklai have given second flush teas which could not be differentiated when examined by 5 tasters in Calcutta. It may be concluded that there is likely to be little or no difference in quality of second flush teas when applying artificial manures at the rate of 60 lbs. of nitrogen combined with 30 lbs. of potash and phosphoric acid respectively whether these manures are supplied in the autumn or in the spring *vide* Appendix 2.

Organic vs. Inorganic.—There has been and now still is considerable discussion upon the relative merits of inorganic and organic manures. An experiment was carried out at Tocklai in order to ascertain the quality of the tea made with the different kind of manuring.

Manufacture of leaf from Borbhetta plots which have had different manurial treatments for the past 8 years was carried out weekly throughout the season (Appendix 2).

The treatments were :—

No manure.

5 tons cattle manure per acre per annum.

10 ,, ,, ,, ,, ,, ,, ,,

A mixture of { 200 lbs. sulphate of ammonia
30 ,, ,, ,, potash
80 ,, ordinary superphosphate
per acre ...

The average results from 5 tasters indicate a very slight but significant loss in tea value (1/24th anna) over the whole season, from 5 tons cattle manure and from the artificials, and 1/8th anna loss from 10 tons cattle manure.

The loss in quality is associated with crop increase and is not determined by type of manure, artificial giving no greater loss in quality than cattle manure either in the early or late part of the season.

Such loss in quality as there is from manuring, is not confined to any one period in the season, but remains fairly constant throughout.

The average valuations and total crops for the season were as follows :—

	Crop mds. tea per acre.	Valuations As. P.
No manure ...	7.09	12 - 1.77
5 tons cattle manure ...	11.26	12 - 1.22
10 tons cattle manure ...	15.43	12 - 0.36
Artificials ...	12.84	12 - 1.22
Significant difference (P = .05) =		0.45

Soil Acidity.—That tea grows most vigorously on an acid soil is well-known but whether the acidity of the soil has any bearing upon the quality of the made tea has not been known until an experiment carried out during this year has shown that 5 tasters could find no difference in the quality of the tea within wide limits of acidity. There was however an indication not statistically significant that the heavy addition of sulphur resulting in a highly acid soil did reduce the value of the tea slightly. The reduction of acidity by the use of lime did not appear to have any appreciable effect upon the quality of the tea made.

Pruning.—Experiments carried out in previous years have shown that bushes "cleaned out" when top-pruning gave better quality tea than bushes that were only "cut across". Some planters have supposed that more severe cleaning out than the removal of *banjhis* and weak shoots results in a still further improvement in quality. This, however, has not been borne out by the results of an experiment at Tocklai. The removal of *banjhi* shoots appears to be an important factor and further cleaning out has not given a further improvement in quality.

When annually top-pruning a certain amount of new wood is left on the bush from which the new growth of the next season is developed. The results of an experiment carried out at Tocklai show that the length of wood left on the bush at the time of pruning varying between less than ¼—1½ inches of length makes no difference to the crop but that a very slight improvement in quality is noticed by increasing the length of wood left at the time of pruning. (*Vide* Appendix 2).

Fermentation.—It has often been noticed that different *jats* of tea ferment differently. The reason for this difference is dependent upon the difference in the amount of vitamin C oxidase in the shoots of the different *jats*. This varies but little during the season for any one *jat* but in one slow fermenting tea the amount increased towards the end of the season and

fermentation then behaved in a manner similar to that of the more rapidly fermenting *jats*.

The amount of oxygen taken up during fermentation does not appreciably vary with change of fermentation temperature. Only the rate at which the absorption takes place varies. During fermentation coloured substances are produced which seemingly may vary considerably and affect the character of the final tea. Tea fermented at 70°F. is better than tea fermented at higher temperature, the quality factor being one noticeably influenced.

Recently in order to more easily obtain clean fermentation conditions in the factory, leaf has been spread on polished aluminium sheets supported off the floor. An experiment has shown that the temperature of the fermenting leaf can be 2°F. to 3°F. above the temperature of the leaf fermenting on a cement floor. The reason for the rise of temperature is attributed to the non-radiation of heat from the polished aluminium and to overcome this the underside of the aluminium sheet has been painted dull black with the result that fermentation temperature of the leaf on the sheets painted dull black on the underside was about 2°F. to 3°F. cooler than the leaf fermented on the sheets polished on both sides. Whilst this gives no direct comparison between fermentation on a cement floor and fermentation on painted aluminium sheets yet it does suggest that there need be no great difference in fermentation temperatures on these two surfaces in properly designed and ventilated rooms.

The thickness of spreading influences the fermentation temperature and whether on aluminium sheets or cement, a thickness of spread over one inch causes an increase of temperature and a corresponding lowering of the value of the made tea.

At a temperature of 70°F. the leaf on the fermenting beds develops a yellowish green colour rather than a red copper colour. After firing this leaf gives a bright copper coloured infusion.

Starch.—The amount of starch in the roots of a tea bush affords a useful indication of the condition of the bush. A suitable method for accurately estimating the starch has been found. The starch falls to a minimum when the new growth appears then gradually rises not reaching a maximum until December.

Wound Paint—Bitumen.—Bitumen mixed with kerosene used as a paint affords good protection to pruning cuts and has also been found to stimulate callus growth. The addition of turpentine or rosin to the paint gave no added advantage. There are several grades of bitumen—the hardest one that was used, 20/30, has given the best results. The callus formation is better on cuts that are painted immediately they are made rather than when painted two weeks after making the cuts. Callus formation is better on cuts that are made adjoining new wood rather than when adjoining old wood.

Black Rot.—The use of 1% Burgundy mixture applied in the growing season to bushes obviously attacked by Black Rot still remains the most satisfactory recommendation that can be made. Cold weather spraying for the control of Black Rot continues to show no significant result.

Eelworm.—Eelworm does a considerable amount of damage in nurseries. Previous experiments at Tocklai showed that this damage was reduced if the plants were grown under shade. Further experiments indicate that burning one foot of dry thatch grass or pouring 16 gallons of boiling water per square yard on the nursery bed before planting the seed can raise the soil temperature to a depth of 3″ sufficiently to be useful in the control of Eelworm. The boiling water method however does not seem to have much practical application.

Experiments on Estates.—The results of 24 experiments of a similar design carried out in various parts of the tea districts in North-East India indicate a general need for nitrogen and that potash and phosphoric acid show apparent gains higher than would be expected if either of them was really without

effect. The conclusion however is justified that the average tea soils so far examined show little immediate need of phosphoric acid or potash. Details of these experiments are to be found in Appendix 3.

Field experiments continue to show that the response to nitrogen manuring is proportional to the amount of nitrogen applied for any particular manure. Also that the efficiency of organic manures such as cattle manure and compost is not more than 50% that of Sulphate of ammonia for an equal quantity of nitrogen. Appendix 4.

Sulphate of ammonia has now been added for 19 consecutive years except in 1933 to plots at Tocklai. These plots still carry the best looking and the best cropping bushes compared with bushes receiving the same quantity of nitrogen in other forms.

The jungle plant *Eupatorium odoratum* commonly known as the Giant ageratum grows in a prolific manner in most parts of the tea districts. It is useful to know that an experiment carried out at Tocklai shews this plant to have a manurial value when cut and directly applied to the soil and that additional nitrogen is unnecessary. Details of the experiment are in Appendix 4.

Boga medeloa was grown amongst plucking tea during 1934-35. In the spring of 1936 boga medeloa was dug up and the green parts hoed into the soil. The crop in 1938 continues to show a big residual effect which has now extended over 3 years. The total gain in crop resulting from growing boga medeloa for two years is 6.6 mds. tea per acre. 30 lbs. of nitrogen as Sulphate of ammonia applied in 1934 and again in 1935 have given a total crop increase of 4¼ mds. during the same period of time.

APPENDIX 1.

Manuring of Replanted Tea.

The following suggestion for manuring of replanted tea are based partly on results obtained at Borbhetta and partly on observations made on gardens where replanting programmes have been in progress during the past few years.

The practice of applying cattle manure at the time of replanting is one which is strongly recommended. 10 lbs. of well rotted manure, mixed with the soil which is filled in round the plant has been found to have a very marked good effect on plants put out on "worn-out" soils. This good effect is ascribed to a great extent to the resulting improved physical condition of the soil, encouraging the spread of the roots of the young plant. Organic "auxiliary food factors" also probably are of some value to young tea. Good well-rotted compost probably has a similar effect.

It is very desirable that shade trees be planted soon after replanting is done. Usually February is the best time. The best shade tree is considered generally to be the ordinary Sau or Siris (Albizzia stipulata) but its most serious disadvantage is its liability to canker. This is true particularly when the tree is planted in areas of mature tea, which reduces the vigour of the Sau trees, and alongside older Sau trees from which the young trees contract the canker. If Sau is put out at the same time as the young tea, in an area which has been cleared of all previously growing shade and other trees, the liability to canker is much less and the young trees grow more vigorously from the start, and are generally observed to last longer. The best distance apart for shade where quality is a consideration is considered to be 55 × 55 ft. triangular, or 48 × 48 ft. square.

It may be considered to be established by observation that the effect of leguminous trees on crop and health is great, but that over-heavy shade reduces quality. Crop would be greater with trees perhaps as close as 30 × 30 ft. The distance apart

suggested as unlikely to reduce quality significantly is not based on any exact experiment, but is only a rough guess based on observation.

After the shade has been put out, the next operation is establishment of boga medeloa, which should be put out in March. The seed should be sown very thinly in alternate lines of tea, and the plants kept lopped up the sides and across the top at 5 ft. throughout the rains. Probably one lopping in the first year (September), and three in the second year will be sufficient. Generally it is best to remove heavy stems and roots after one more lopping in May of the third year.

On the manuring of young tea in the first three years after planting, experiments at Borbhetta on tea planted in 1935-36 cold weather have given the following information :—

(1). Application of 60 lbs. nitrogen as sulphate of ammonia gave poorer results than application of only 20 lbs. nitrogen in the same form.

In the first year after planting the percentage of deaths were as follows :—

	% deaths.
60 lbs. nitrogen (300 lbs. sulphate of ammonia)	12.6
20 lbs. nitrogen (100 lbs. sulphate of ammonia)	10.5

The high percentage of deaths was due to hail, following drought; but the difference due to the bigger dressing of sulphate of ammonia is significant. At the end of the second year bushes were cut across at 18" and the prunings were weighed. A significantly greater weight of prunings was obtained from the plots getting 100 lbs. sulphate of ammonia, than from the plots getting the larger dose.

In the third year results both in crop during 1938, and on the weights of pruning at the end of 1938, were equal whether 20 or 60 lbs. nitrogen per acre were used.

(2). Potash has a beneficial effect on young tea. The weight of prunings is taken as an index of the effect of the manures during the first two years. Plots getting potash gave significantly larger weights of prunings than those which had no potash, and the weights of prunings increased with the dressing of potash.

In the third year (1938), both on the crops plucked and on the weights of prunings, 20 lbs. potash per acre showed a significant good effect, while 60 lbs. potash showed three times that effect.

(3). Phosphoric acid had no significant effect, either on weight of prunings, or on crop; but a small good effect was indicated, while it showed significant good effect in reducing intensity of attack by red spider. Its inclusion in the manure is therefore on the safe side. 60 lbs. phosphoric acid had no better effect than 20 lbs. on crop, prunings, or red spider attack.

The manures were forked in round the plants in early April in the first year. It is known that sulphate of ammonia has an initial depressing effect lasting about 3 weeks, and its concentration round the bushes at a period of the year when they carry little leaf and are likely to be weak, has a temporary bad effect, which would be obviated by later application, say in June or July, when the plants have had a chance to put on a fair quantity of leaf. In 1937 and 1938 applications on the experimental plots were in late June.

The annual manure mixture recommended for replanted tea in its first three years is:—

1 part sulphate of ammonia;
1 ,, ,, ,, potash;
1 ,, ordinary superphosphate.

The rate of application advised is 2 ozs. of mixture per plant forked in, in June or July, round the plant in a ring of 18 inches outer and 6 ins. inner diameter. With 4½ × 4¼ ft.

triangular planting, 2 ozs. per plant requires 310 lbs. per acre of the mixture. This supplies, per acre, about 22 lbs. nitrogen, 54 lbs. of potash, and 22 lbs. phosphoric acid, at a cost of about Rs. 17/- per acre.

In the second and third years, the diameter of the circle of application should be increased so that its circumference is outside the spread of the branches.

The application of manure recommended for the fourth and subsequent years after planting is 200 lbs. sulphate of ammonia applied broadcast as for mature tea. We have, as yet, no definite information on the value of potash and phosphoric acid after the third year, but it is probable that as the bushes approach maturity the need for potash will be reduced. We get only very small effect from potash or phosphoric acid on mature tea in plucking.

Those gardens which are fortunate enough to have cheap supplies of cattle manure or humus compost available in sufficient quantity, may use those supplies for manuring young tea, in the second and third years as well as in the first year. About 5 tons per acre will be about equivalent to the 310 lbs. artificial mixture, except that it will not supply so much available potash. ½ oz. of sulphate of potash per bush in addition to 4½ lbs. cattle manure probably would be found advantageous.

APPENDIX 2.

EXPERIMENTS ON THE QUALITY OF TEA 1938 SEASON.

(1). Autumn and Spring Manuring.

(2). Effect of Manures—Inorganic and Organic.

(3). Effect of Alterations in Soil Acidity by the use of Lime and Sulphur on the Soil.

(4). Effect of Degree of Cleaning out, and Length of New Wood left in Pruning.

(1). *Autumn v. Spring application of inorganic mixture.*

Since 1934 a set of plots has been annually manured at the beginning of October, and another similar set, at the end of March. Both sets received an inorganic mixture supplying 60 lbs. nitrogen and 30 lbs. each of potash and phosphoric acid.

Each year the total crops have been practically the same from both sets of plots, but the autumn manuring gives a slightly larger early and late crop, and a correspondingly smaller rains crop. The increases in early and late crop are however exceedingly small, and not always significant. For instance, up to the end of June, 1938, the autumn manuring gave 2.71 mds. tea per acre, compared with 2.51 mds. from the spring manuring, a difference not statistically significant.

During this period in 1938, leaf from these plots was manufactured on three occasions, and teas sent to 5 tasters in Calcutta for valuation.

Individual tasters, averages in annas and pies.

	Tasters.					
	A	B	C	D	E	Average.
March ...	14-1.7	13-2.0	13-7.3	12-11.8	12-10.3	13-4.2
October ...	14-2.7	13-1.0	13-7.7	12-11.8	12-10.7	13-4.4

No single taster finds any significant difference in valuation of second flush teas between the two times of manuring, nor are the averages of all tasters significantly different. In regard to the various characters of leaf and liquor, there is nothing in it between the two sets of samples.

One may conclude, then, that it makes no difference to quality of second flush teas, when applying artificials in quantities up to those applied in the experiment, whether the manures are applied in the autumn or in the spring.

(2). *The effect of Manuring with Artificials and Bulk organics on the characters and value of tea.*

Throughout the 1938 season leaf was manufactured weekly from four series of plots of Tingamira tea at Borbhetta. Of these series one has never been manured; one has had nothing but artificials annually for the past 8 years, and two have had cattle manure annually for 8 years (except in 1932 when unmanured). All series were unmanured up to 1931.

The artificials consisted of a mixture of 200 lbs. sulphate of ammonia, 80 lbs. ordinary superphosphate, and 30 lbs. sulphate of potash per acre, thus supplying a 40/15/15 N.P.K. mixture. Of the cattle manured series, one received 5 tons and the other 10 tons per acre. The analysis of the 1938 application gave 0.65% nitrogen, 0.478% phosphoric acid, and 0.360% potash, thus supplying a 73/53/40 lbs. N.P.K. application in the case of the 5-ton plots and twice these quantities on the 10-ton plots.

It was not possible to manufacture leaf separately from all the replicate plots from each series, firstly because quantities of leaf from single plots were insufficient, and secondly because the number of samples which could be tasted and compared as a group was limited. Therefore the leaf from pairs of plots was bulked, and the resulting bulked leaf from three such pairs were manufactured each week, making a total of 12 samples

per week. The resulting teas were tasted on each occasion by five tasters in India.

Throughout the second flush period before the C.T.C. machine was installed, the system of manufacture employed was as follows :—

The 12 samples of fresh leaf each of the same weight (which varied from week to week from one to four pounds), were spread on trays to wither. The withered leaf (preferably 100 lbs. to 70 lbs. slightly underwithered) was placed in enamelled bowls and rolled by hand for three spells; one of one hour and two of half an hour each, with half an hour's fermentation between each hand-roll. The samples were all fired together for 40 mins. on the top tray of a Sirocco Tilting Tray drier. The sifting consisted in first cutting the dry tea in a Savage cutter with 3/8" cells and then passing it over an aluminium sieve with 1/8" square holes. The tea passing through, was passed over a sieve with 3/64" holes and what did not pass through was retained. What passed through was dust and small fannings which were discarded.

The coarse tea which did not pass the 1/8" sieve was cut with 1/4" cells and again passed over 1/8" and 3/64" sieves. About 7% did not pass the 1/8" sieve and was discarded, while some more dust and small fannings passed through the 3/64" sieve and was discarded. This with the first lot of dust and fannings amounted to about 10% of the bulk. The first and second lots of medium sized tea were well mixed and amounted to about 80-85% of the total bulk. This was carefully sampled for tasting purposes.

During the rains and autumnal period, when the C. T. C. machine was available, the hand rolling was cut down to a single roll of 30 minutes, after which the samples were put through the C. T. C. once each, and fermented for 2 to 2½ hrs. before firing. The C. T. C. cuts the leaf up finely and it was found that for sorting purposes, the one cutting with 1/4" cells was

sufficient, the preliminary cutting with 3/8" cells being eliminated.

The season may conveniently be divided into three periods, (*a*). The "Second flush", up to 19th July, (*b*). "Rains" from 26th July to 18th October and (*c*). "Autumnal", from 25th October to 29th November.

Complete valuations for all three periods are given in the appendix. A graph showing the relative weekly valuations and crops for the four manurial treatments throughout the season is also given.

(a). The "Second flush" period.

Results for this period are discussed at length in the Quarterly Report for the Chemical Branch for the 3rd Quarter 1938, and the following total crop and average valuations for the second flush period are taken from this report.

	Mds. tea per acre.	Average valuation. As. P.
Unmanured ...	1.68	13 - 10.55
5 tons cattle manure (75N. 53P. 40K) ...	2.68	13 - 9.87
Artificial (40N. 15P. 15K.)	3.31	13 - 9.85
10 tons cattle manure ...	3.98	13 - 9.31
Significant difference for Valuations (P = .05) =		0.795

The first point of interest in these results is the extremely small lowering in valuation (1/10th of an anna) even with the highest level manuring—10 tons cattle manure. The lower levels of manuring—5 tons cattle manure and the artificials (40 lbs. nitrogen) do not lower valuations significantly. In comparision with the increased second flush crop obtained from manuring, the drop in valuation, even where significant, is negligible.

The relative total values per acre of the second flush crops from these four treatments are as follows :—

No manure	...	Rs. 116/- per acre
5 tons cattle manure	...	,, 185/- ,, ,,
10 ,, ,, ,,	...	,, 274/- ,, ,,
Artificials (40 lbs. N)	...	,, 229/- ,, ,,

It is of very great interest to observe that the artificial manure, supplying only 40 lbs. nitrogen, has produced no worse teas, yet a considerably larger crop of second flush, than the 5-ton cattle manure application which supplied 73 lbs. per acre of nitrogen.

Over the second flush period manuring has not apparently affected leaf characters, but gives slightly more coloury liquors, with more strength and but little less quality than teas from unmanured plots.

(*b*). *Rains period.*

It might be expected, during the rains period when teas fall to a steady and comparatively low level of quality, that manures which make only a very small difference to second flush teas, might have no appreciable effect on rains teas. The results of experiments however indicate that such differences in quality as do occur in second flush teas, due to manuring, persist throughout the season. The average valuations, and crop, during the rains period (26th July to 19th October) are as follows :—

		Crop Mds. tea per acre.	Valuations. As. P.
No manure	...	4.24	11 - 3.79
5 tons cattle manure	...	6.80	11 - 3.19
10 ,, ,, ,,	...	9.14	11 - 2.57
Artificials	...	7.66	11 - 3.44
Significant difference (P = .05) =			0.62

10 tons cattle manure has lowered the valuation of the teas by 1.22 pies, (which is a significant drop), compared with unmanured teas; and by 0.622 pies and 0.870 pies respectively compared with teas manured with 5 tons cattle manure and with artificials. These are also significant differences. Neither the 5 tons of cattle manure nor the artificial has caused significant lowering in valuation compared with no manure, though in the case of the 5-ton cattle manure, the drop of 0.60 pies is near the 19 to 1 level of significance.

Again no effect on leaf characters of rains teas has resulted from manuring, nor is there any appreciable effect on colour of liquors. There is however a very slight tendency in the case of the heavier manuring, to a reduction in briskness, strength and quality.

The relative values of the crops per acre over the rains period are :—

No manure	...	Rs. 240/-
5 tons cattle manure	...	,, 383/-
10 ,, ,, ,,	...	,, 512/-
Artificials ...	...	,, 433/-

(*c*). *Autumnal period.*

Over this period there was only sufficient leaf available to make 6 sets of manufacture, from 25th October to 29th November.

The average valuations and total crop for this period are as follows :—

	Crop Mds. tea per acre.	Valuations. As. P.
No manure ...	1.17	10 - 7.82
5 tons cattle manure ...	1.78	10 - 7.48
10 ,, ,, ,, ...	2.31	10 - 6.22
Artificials ...	1.87	10 - 7.20
Significant difference (P = .05) =		0.622

Again the heavy application of cattle manure has produced teas significantly lower in value than the unmanured teas, and the teas from plots manured with 5 tons cattle manure or artificials. The difference between the valuation of the artificial manured teas and those unmanured, is on the verge of significance. Manures again have not affected the appearance of the teas, nor have they affected colour or strength. There is some slight loss in briskness and quality however, in the case of teas manured with the 10-ton application of cattle manure.

Over the whole season the crops and valuations are as follows :—

	Crop Mds. tea per acre.	Valuations. As. P.
No manure ...	7.09	12 - 1.77
5 tons cattle manure ...	11.26	12 - 1.22
10 ,, ,, ,, ...	15.43	12 - 0.36
Artificials ...	12.84	12 - 1.22
Significant difference (P = .05) =		0.45

Taking the average of all 26 occasions of manufacture, even the 5-ton application of cattle manure, and the artificial supplying 40 lbs. nitrogen and 15 lbs. each of potash and phosphoric acid per acre, have produced significant decreases in valuation. This decrease is exceedingly slight, amounting to 1/24th anna only (half a pie). In the case of the heavy application of cattle manure the decrease is nearly 1½ pies.

The results of this experiment show effectively that the lowering of quality of tea by manuring is not determined by the type of manure, artificial or organic, but is a result of increase in crop. One must evidently expect some falling off in tea value even if only slight by manuring to raise the crop from 7 to 11 mds. per acre, and still more falling off with greater crop increases. One can however be fairly certain that such falling off will be very little with crops of up to 14 or 15 mds. per acre, and that the use of a bulk organic manure such as cattle manure in preference to artificials will not reduce this loss in quality.

(3). *Influence of Soil Acidity on Tea Value.*

The question of the effect which soil acidity has on tea value is one which was referred to at the Second Annual Conference in February, 1938, and it was then stated that little or nothing was known on the subject. The following two experiments were therefore planned to obtain some information on the effect, if any, on the quality of teas made, from bushes growing on soils of widely different soil acidities. The plots chosen were from an area of Betjan tea; on one set the plots have had no lime or sulphur application and their average acidity is 5.4 pH; another had application of lime to bring the acidity to pH 6.5 or higher (almost neutrality); while a third series had sufficient sulphur to bring the acidity to a pH of 3.5 during the early part of the rains period when the first experimental manufacture was done. By the end of the season, at the time of the second set of manufacture, the soil acidity had decreased considerably probably owing to the leaching out of free acid from the soil during the wet season, and the average pH of the sulphured plots was about 5.0. This indicates a considerably more acid condition than that of the untreated plots, but one which is quite normal in many tea soils.

Duplicate samples of leaf from each of these three series were manufactured for 6 successive weeks during July and August, and on three occasions at the end of the season the same three treatments were manufactured in quadruplicate. Valuations and reports were obtained from 5 tasters in India and from 11 tasters in London to whom all sets of teas were sent.

(1). *The early rains period.*

In the following table, the soil acidities taken during the spring, the crops up to the middle of August, and the average valuations from Calcutta and London for the teas made, are given for each of the three treatments, in duplicate.

Soil treatment	Plot group	Soil Acidity			Crop mds. per acre	Average valuation of made teas.	
		Hopkins acidity	pH of soil water	pH of neutral salt-extract		Calcutta as. p.	London s. d.
Lime ...	A	*nil*	7·10	7·30	8·13	12·7·3	1·7·03
	B	*nil*	7·09	7·12	9·30	12·6·9	1·6·86
No treatment	A	487	5·19	4·07	7·67	12·8·0	1·6·88
	B	444	5·20	4·14	8·16	12·6·5	1·6·81
Sulphur ...	A	919	3·65	3·75	7·83	12·6·0	1·6·97
	B	880	3·69	3·81	8·27	12·6·4	1·6·55

The average valuations are those of the 5 tasters in Calcutta and the 11 tasters in London. There are no significant differences between any of the two sets of valuations, and it would appear that soil acidity may vary between wide limits without affecting the quality of the made teas. There is however an indication, not statistically significant, that the heavy sulphur application has reduced the value of the teas slightly.

(*b*). *Late Autumnal Period.*

During this period, on 17th November and the 1st and 8th of December, four samples of leaf from each of the series :—

(1). Receiving no treatment
(2). Heavily limed
(3). Heavily sulphured

were manufactured. Thus on each occasion there were 12 samples of tea which were sent to each of 5 tasters in Calcutta. Owing to shortage of leaf, it was impossible to obtain enough of each sample, on each occasion of manufacture, to supply all 11 London tasters. The first set were sent to 7 London tasters, the second to 4, while the third set were not sent to London.

The following table gives the average results from London and Calcutta together with soil acidities taken in November, and total crops for the year.

...	Soil acidities		pH of neutral salt extract	Total crop mds. tea per acre.	Valuations	
	Hopkins acidity.	pH of soil water.			Calcutta	London*
					ss. p.	s. d.
Lime ...	Alkaline	7·06	7·12	13·90	11·1·70	1·5·45
nil ...	369	5·46	4·12	13·37	10·11·95	1·5·29
Sulphur ...	530	5·00	3·85	13·27	10·10·45	1·5·23

*Average of two sets only.

The above results indicate, as in the experiment done during the early rains, that there is apparently a slight reduction in tea value resulting from the sulphur application to the soil. The differences are not however significant nor are there indications of any effect due to the sulphur or lime treatment, on any particular character of leaf or liquor.

(3). *Effect of Pruning on Tea value.*

(*a*). Length of new wood left in pruning.

(*b*). Light versus drastic cleaning out.

Two experiments on this subject were done during 1938, one during the second flush period and one during the rains.

(1). *Experiment during second flush.*

Four treatments were tried, viz.—

(*a*). Cut to previous pruning level; lightly cleaned out;

(*b*). Cut to previous pruning level; drastically cleaned out;

(*c*). 1½ ins. of new wood over previous pruning level; lightly cleaned out;

(*d*). 1½ ins. of new wood over previous pruning level; drastically cleaned out.

These series were manufactured in duplicate on four occasions during May and June, and the teas were sent to 5 Calcutta tasters.

The slightly cleaned out plots had nothing but the *banjhi* twings pulled off by hand, after the bushes had been cut across at the required level. The drastically cleaned out bushes, had in addition to removal of *banjhi* twigs; the dead and weak wood taken out, and also the other twigs spaced out so that they were not closer than 4", (or a hands breadth) apart.

This system of clean pruning is common in part of Assam and is considered to be better for quality, though it is realised that less crop is obtained.

Results from the experiment over the second flush do not however indicate any better quality of tea from bushes drastically cleaned out, as the results below show :—

Height of pruning above previous year.	Cleaning out.	mds. tea per acre to end June	Average valuations of 5 Calcutta tasters.
			as. p.
nil	banjhis only	2·86	14-4·06
nil	spaced out	2·60	14-4·04
1½ inches	banjhis only	2·77	14-4·87
1½ inches	spaced	2·58	14-5·41

The average valuations for cleaning out are :—

	As. P.
Banjhis only ...	14 - 4.46
Spaced out ...	14 - 4.72

The difference is not statistically significant and is actually extremely small.

For length of new wood above previous pruning the averages are :—

		As. P.
Nil	...	14 - 4.05
1½ inches	...	14 - 5.14

This difference is not actually significant but amounts to over a pie per pound and indicates the possibility of some improvement in tea value from leaving longer wood, in pruning.

(2). *Rains period.*

From 18th August to 6th October there were 8 manufactures of leaf from eight different combinations of 4 different lengths of wood and two degrees of cleaning out.

Teas were sent to the same 5 Calcutta tasters who valued in the previous experiment, and also to 11 London tasters.

The table below gives crops and average valuations for the series of manufactures.

Height of pruning above previous year.	Cleaning out.	Total crop mds. tea per acre.	Valuations	
			Calcutta.	London.
		mds.	as. p	s. d.
0″	banjhis only	14·15	10-8 95	1-3·56
½″	,,	13·35	10-8·75	1-3·64
1″	,,	14·12	10-9·05	1-3·62
1½″	,,	13·70	10-9·15	1-3·76
0″	spaced out	13·04	10-8·75	1-3·47
½″	,,	13·08	10-9·07	1-3·50
1″	,,	13·05	10-9·30	1-3·69
1½″	,,	12·96	10-9·22	1-3·73

The valuations of the Calcutta tasters show no differences due to length of pruning wood, or to degree of cleaning out, which are statistically significant.

The average valuations for degree of cleaning out are—

	As. P.
Banjhis only	... 10 - 8.98
Spaced out	... 10 - 9.08

Valuations are practically identical.

For length of new wood the valuations are:—

Height above previous pruning.	As. P.
0 inch	... 10 - 8.85
½ inch	... 10 - 8.91
1 inch	... 10 - 9.17
1½ ins.	... 10 - 9.18

There is a tendency as in the 2nd flush period towards better valuations resulting from the longer length of wood but differences are not statistically significant.

The London tasters' results do show differences in valuation due to length of wood which are significant even on the .01 level of probability.

The average valuations for different lengths of wood are—

Height above previous pruning.	Valuations. *s.* *d.*
0 inch	... 1 - 3.52
½ inch	... 1 - 3.57
1 inch	... 1 - 3.65
1½ ins.	... 1 - 3.75

The differences required for significance are—

for p = .05 ... .117 *d.*
for p = .01 ... .156 *d.*

Thus the teas from bushes pruned leaving 1½" of new wood over the previous pruning level are significantly better valued by the London tasters than teas from bushes pruned level with, or ½" above the previous year.

Taking the lower level of significance, leaving ½" wood above the previous pruning has produced better tea than by cutting level with the previous year's pruning. We cannot however say that there is any significant difference between leaving 1" or 1½" pruning wood above the previous level.

It is interesting to note that a very high degree of accuracy in this experiment has been reached by the team of 11 London tasters. If the results of any five are selected however, and combined together, the degree of accuracy is greatly reduced. If it were possible to increase the numbers of the Calcutta group, there is no doubt that accuracy would be greatly increased.

APPENDIX 3.

Experiments on Estates.

Potash and Phosphoric Acid.

1938 is the second year of similar treatment except at Seajuli where it is the third year of similar treatment.

Nitrogen as sulphate of ammonia.
Phosphoric acid as superphosphate.
Potash as sulphate of potash.

Except where otherwise stated,
Nitrogen 40 lbs. per acre.
Phosphoric acid 30 lbs. per acre.
Potash 30 lbs. per acre.

Results are recorded in mds. tea per acre.

The "significant difference" by the "t" test, is placed in brackets where the "Z" test is not passed.

	Mds. tea per acre manuring.					Significant difference	Notes
	Nil	N	NP	NK	NPK		
Cachar Teela and plateau soil							
Silcoorie ...	5·4	5·9	6·8	6·2	6·2	(1·42)	
Durgakhuna ...	8.4	9·6	10·7	11·1	10·5	1·14	N. Significant.
Seriapore ...	17·2	17·4	18·5	17·9	17·9	(1·67)	
Khoreel ...	8·8	11·7	11·7	12·2	12·0	1·08	N. Significant.
Cachar Clay Flats.							
Ruttonpore ...	2·7	4·2	5·1	4·6	5·3	1·14	N. and P. Significant.
Chandypore ...	4·1	5·7	5·1	5·8	5·9	1·12	N. Significant.
Cachar old bheels.							
Lallamookh ...	10·4	13·2	13·0	13·7	13·9	1·14	N. Significant.
Lallacherra ...	3·3	3·9	4·7	3·7	4·1	(1·12)	
Rich heavy flats, Cachar.							
Singalla ...	16·4	19·7	19·4	19·4	19·1	1·85	N (60 lbs.) significant
Derby ...	16·1	16·0	16·3	15·2	15·9	(1·22)	N=40 & 80. P=40 & 80 K=40 & 80
Rich Bheel soils.							
Poloi ...	15·8	16·9	15·8	17·2	16·8	(2·38)	
Luckynugger ...	12·5	12·8	13·4	12·8	13·1	(1·55)	N=60 lbs.
Rich Red loam on flat, Cachar.							
Burnie Brass ...	11·4	16·1	16·0	16·0	16·7	1·30	60 lbs. N. Significant.

	Mds. tea per acre.					Significant difference	Notes
	Nil.	N	NP	NK	NPK		
Duars. Red Bank							
Moortee ...	3·2	5·0	5·8	5·6	5·2	1·01	Crop depressed by severe drought on Southern slope N. Significant.
Matelli ...	9·1	11·1	12·9	12·3	12·1	0·98	N. and P. both significant.
Duars grey sandy loam							
Rydak ..	14·3	15·2	15·4	16·0	15·7	0·87	N. significant.
Kartik ...	16·0	16·5	17·2	16·7	16·2	(1·21)	
Duars Coarse sand.							
Baradighi ...	8·4	9·8	10·0	9·6	10·6	1·09	N. significant.
Assam, North Bank of Brahmaputra. Sandy soils							
Seajuli ...	8·4	12·0	12·1	12·7	12·5	0·92	60 lbs. N. significant.
No. 5 New Gogra	4·9	5·6	6·0	6·3	6·1	0·97	mean of all plots receiving nitrogen against "no nitrogen" significant.
No. 7 Bindukuri	8·3	9·2	9·3	9·3	9·7	(0·97)	
No. 4 New Gogra	8·4	9·0	9·9	10·0	9·4	(1·50)	
Red Bank Soils							
No. 3 Old Gora ...	7·1	8·0	8·0	7·8	8·1	0·72	N. significant.
No. 4 Old Gogra	7·9	8·7	8·9	8·7	9·0	0·87	N. significant.

Here we have results of 24 experiments of similar design.

The effect of nitrogen proves significant in 16 cases. Of the other 8 cases it may be guessed that in four cases the nitrogen is having effect but the experimental error is so high that the effect is not shown as significant; while in the remaining four cases it is probable that the soil has naturally as much nitrogen as the bushes can use.

Phosphoric acid is shown to have "significant" effect in two cases only. As the meaning of "significant" is that a difference of the magnitude recorded would occur less than once in twenty similar trials, the finding of 2 "significant" cases in 24 trials is not much above the number expected if, in fact, phosphoric acid were having no effect.

Taking all the twenty-four cases, we find the gains to be as below. Apparent losses are indicated by a minus sign.

	gains in mds. tea per acre.		
	Nitrogen alone compared to no manure	Average increase over nitrogen alone by *using together with nitrogen*	
		Phosphoric acid	Potash.
Silcoorie	0·5	0·45	0·15
Durgaklinna	1·2	0·24	0·61
Serispore	0·2	0·56	−0·02
Khoreel	2·9	−0·16	0·38
Ruttonpore	1·5	0·78	0·33
Chandypore	1·6	−0·24	0·46
Lallamookh	2·8	−0·05	0·75
Lallacherra	0·6	0·59	−0·40
Singalla	3·3	−0·05	−0·30
Derby	−0·1	0·50	−0·60
Poloi	1·1	−0·75	0·65
Luckynugger	0·3	0·45	0·15
Burnie Braes	4·7	0·30	0·30
Moortee	1·8	0·2	nil
Matelli	2·0	0·8	0·2
Rydak	0·9	−0·05	0·55
Kartick	0·5	0·1	−0·4
Baradighi	1·4	0·6	0·2
Seajuli	3·6	−0·05	0·55
No. 5 New Gogra ...	0·7	−0·05	0·55
No. 7 Bindukuri ...	0·9	0·25	0·25
No. 4 New Gogra ...	0·6	0·15	0·35
No. 3 Old Gogra ...	0·9	0·15	−0·05
No. 4 Old Gogra ...	0·8	0·25	0·05
Average gain	1·45	0·18	0·20
Number of apparent gains ...	23	16	17
Number of apparent losses ...	1	8	6

The number of cases in which both potash and phosphoric acid are showing apparent gains is higher than would be expected, if either of them was really without effect.

However, the conclusion is justified that the average of the tea soils so far examined shows little immediate need of phosphoric acid or potash.

A general need for nitrogen, on the other hand, is strongly indicated.

APPENDIX 4.

Experiments with Cattle Manure, Humus Composts and similar Materials.

1. *Halem. Coarse sandy soil on North Bank, Assam. 6th year of similar treatment.*

Annual manuring per acre	Mds. Tea per acre.	
	total 1938	Gains.
Artificial mixture, 40 lbs. nitrogen ...	14·26	2·02
Cattle manure, 200 mds. 84 lbs nitrogen in 1938 / 90 „ average	13·42	1·18
No manure	12·24	...
Significant difference (for odds of *99 : 1*) ...	0·68	0·68

The artificial shows about double the efficiency of the cattle manure per unit of nitrogen.

The efficiency of both manures is relatively small, presumably because the tea is heavily shaded by Sau trees.

2. *Aenekhal* (bheel soil).

	no nitrogen	5 tons humus compost	200 lbs. sulphate of ammonia	means of 15 plots
With 120 lbs. sulphate of potash per acre ...	4·89	5·14	5·16	5·06
No potash ...	4·98	5·58	5·27	5·28
means of 10 plots ...	4·94	5·36	5·22	

None of the manures shows any significant effect.

The tea yields poorly because cut back on 3-year-old wood, after being unpruned for 3 years.

The failure of the potash has some interest in view of questions asked at the Annual Conference in February.

3. *Luckynugger* (bheel soil).

Unpruned in 1938.

Manure per acre.	*mds. tea per acre,* 1938.
No manure	12.51
5 tons humus compost ...	12.90
200 lbs. sulphate of ammonia ...	12.80
200 lbs. sulphate of ammonia 150 lbs. superphosphate 60 lbs. sulphate of potash	13.10

None of the differences approaches significance.

4. *Champarai—*

Teela soil heavily shaded by Sau trees. (3rd year of similar treatment).

Manure per acre.	*mds. tea per acre,* 1938.
60 lbs. nitrogen as sulphate of ammonia	19.83
60 lbs. nitrogen as humus compost	18.83
No manure	18 68

None of the differences is significant.

5. *Leesh River—*

Coarse sandy soil in Western Dooars. (Second year of similar treatment).

Annual manure per acre.	*mds. tea per acre, total* 1938.	*gains.*
No manure	11.58	—
5 tons humus compost ...	12.32	0.74
10 tons humus compost ...	12.75	1.17
200 lbs. sulphate of ammonia ...	14.75	3.17
400 lbs. sulphate of ammonia ...	16.27	4.69
Significant difference ...	1.20	1.20

10 tons humus compost supplied about as much nitrogen as 400 lbs. sulphate of ammonia.

Sulphate of ammonia so far, has something like four times the efficiency of the humus compost per unit of nitrogen.

6. *Allynugger—*

Sylhet plateau soil. (Second year of similar treatment).

Annual manure per acre	supplying lbs. nitrogen per acre in 1938	mds. tea per acre		estimate cost per acre.
		Total 1938	gains	
				Rs. As. P.
No manure	*nil*	5·31	...	nil
Artificial mixture ...	76	7·18	1·87	30-11-0
Indore compost (fermented) ...	84	6·05	0·74	24-13-0
Dacca compost (fermented) ...	97	5·25	0·94	15- 9-0
Materials for Dacca compost (unfermented) ...	77	6·86	1·56	11- 9-0
Acme Animal Meal ...	95	7·62	2·31	94-12-0
Significant difference	...	0·62	0·62	...

All manures show significant gains over no manure.

Animal meal is not quite significantly better than the artificial, which is not significantly better than the unfermented Dacca materials; but animal meal is significantly better than Dacca materials. Each of these three is significantly better than either fermented humus compost.

The most profitable manure application is the jungle cuttings used together with a little nicifos: followed by the artificial.

7. *Gandrapara. Rich loam in the Dooars.*
(Second year of similar treatment).

Annual manure per acre.	*mds. tea per acre.*	
	total 1938.	*gains.*
No manure	14.84	—
200 lbs. sulphate of ammonia ...	16.97	2.13
Humus compost (fermented) ...	15.06	0.22
Materials for compost (unfermented)	15.53	0.69
Significant difference ...	0.63	0.63

The increase from the use of sulphate of ammonia is highly significant, even on this high-yielding tea.

The unfermented jungle cuttings also yield a significant increase in crop though much less than from sulphate of ammonia.

The apparent gain from the fermented humus compost does not approach significance.

8. *Borbhetta.*

Quantities applied gave as nearly as possible 80 lbs. nitrogen per acre in September 1936 and again in July, 1938.

Manure		*Mds. tea per acre 1938.* total crop
No manure		6·66
Sulphate of ammonia		9·23
Cattle manure		7·76
Fermented Composts	Indore	7·68
	Adco	7·58
	Dacca	7·84
Unfermented materials applied direct to soil	as for Indore Compost ...	7·62
	as for Dacca Compost ...	8·75
Significant difference for odds of 19 to 1		0·44
„ „ „ 99 to 1		0·59

Cattle manure and all the fermented composts are equally efficient within experimental error. Each of these gives less than half the effect of sulphate of ammonia providing the same quantity of nitrogen.

"Adco" compost was prepared from rice straw and calcium cyanamide only.

For Indore compost the materials used were :—

Rice straw.
Cattle manure.
Urine earth.
Wood ashes.

The same materials (kept under cover during the making of the compost) applied at the same time as the compost was applied, to give the same quantity of nitrogen as contained in the finished compost, gave practically the same effect as the finished compost. As about 20% of the nitrogen was lost during compost-

ing, the cost of the compost, with manufacturing costs added, was much greater than that of the raw materials applied direct to the soil.

The Dacca compost was prepared from :—

Cut jungle (Mellastoma spp.);
Cattle manure;
and a little nicifos.

In this case the materials were bulked at site, and the correct weights applied to one plot. The same weights of the same materials made up the first layer of the compost heap. This was repeated till 7 plots had been manured, and a heap of seven layers prepared. After the specified treatment (watering, turning, etc.), extending over three months, the "Dacca" compost heap was weighted, and one-seventh of the total weight applied to each of seven other plots of tea. The materials applied direct supplied 90 lbs. nitrogen per acre, while the same materials after composting supplied only 70 lbs. nitrogen per acre. The uncomposted materials however are more efficient per unit of nitrogen applied. This is in agreement with the results of the similar trials at Allynugger, and at Gandrapara. There is no gain, but only loss, from the expensive operation of composting. In view of these results, one in Assam, one in Sylhet, and one in the Dooars, it can no longer be doubted that the best use which can be made of any available waste material is to carry it, after drying in the sun, to reduce cost of transport, direct into the tea.

9. *Appication of cut-jungle direct to the soil.*

The commonest suitable plant likely to be found in quantity in the neighbourhood of tea is the blue-flowered perennial shrub *Eupatorium adaratum*, commonly called Giant Ageratum because its flower resembles that of the common tea-garden annual weed. Cuttings of this plant average over 60 times as much organic matter as nitrogen, and current theories would lead to the supposition that such material should prove very

slow in action as manure, and might even produce a depression in rate of growth of tea among which it is buried. Such preliminary bad effects, on the same current theories, should be avoided by use, together with the jungle-cuttings, of some readily available nitrogen compound. Calcium cyanamide would be expected to prove particularly suitable for this purpose on account of its content of lime.

Comparison of the following nine treatments was therefore commenced in 1938 at Borbhetta :—

		Manure per acre.	
		Sun dried Eupatorium cuttings.	Calcium cyanamide.
1	...	nil	nil
2	...	3 tons	nil
3	...	6 tons	nil
4	...	nil	1½ cwt.
5	...	3 tons	,,
6	...	6 tons	,,
7	...	nil	3 cwt.
8	...	3 tons	,,
9	...	6 tons	,,

The treatments compared therefore include :—

1. No manure.

4 and 7. Quick-acting artificial alone, at 2 rates of application.

2 and 3. Jungle cuttings with 64 times as much organic matter as nitrogen, at 2 rates.

6. Jungle cuttings and cyanamide with 51 times as much organic matter as nitrogen.

5 and 9. Jungle cuttings and cyanamide with 37 times as much organic matter as nitrogen, at 2 rates.

8. Jungle cuttings and cyanamide with 26 times as much organic matter as nitrogen.

The results in the first year are of the greatest interest, since effects can be observed free from complication by residual effects of manuring in previous years. The time of application (end of May) was such that any depression in rate of growth of tea would be observed, easily, in relative loss of crop. If there were any advantage in using cyanamide together with the jungle, so that the two together gave more crop (even temporarily) than the sum of the two separately, that also would be readily observed.

It was found that not only was there never any sign of depression in crop even from the heavier dressing (6 tons per acre) of jungle cuttings used alone, but that the jungle cuttings yielded increased crop of tea just as soon as did the quick-acting cyanamide. Similarly no significant advantage appeared from using cyanamide together with jungle cuttings. Within experimental error, increase in crop from the two together was equal to the sum of the increases from each separately.

Cuttings of eupatorium therefore behave as a quick-acting manure.

It was observed in the field that the leaves and young green stems had rotted completely, and disappeared from sight, before the heavier wood showed any noticeable sign of rotting. Leaves and woody stems act independently. The rapid decomposition of the leaves (with only 22 times as much organic matter as nitrogen) is not appreciably affected by the presence in the soil of slowly-rotting wood (with 130 times as much organic matter as nitrogen).

The leaves and green stems contained 77% of the nitrogen in the whole cuttings, and the nitrogen in the whole cuttings showed about 70% of the efficiency shown by the nitrogen in the cyanamide.

		tons Eupatorium per acre			Average
		0	3	6	
cwts. cyanamide per acre	0	7·05	7·49	7·97	7·50
	1½	7·29	8·57	8·92	8·26
	3	8·05	8·67	9·12	8·62
Average		7·48	8·23	8·68	

Average gains from :—

1½ cwt. cyanamide	...	0.76	mds. tea.
3 cwt. cyanamide	...	1.12	,, ,,
3 tons Eupatorium cuttings	...	0.75	,, ,,
6 tons Eupatorium cuttings	...	1.20	,, ,,
Significant difference	...	0.40	,, ,,

3 tons cuttings have about the same effect as 1½ cwt. cyanamide, and 6 tons cuttings have about the same effect as 3 cwt. cyanamide. It is very possible that the residual effect of the cuttings may prove relatively higher than of the cyanamide.

In the meantime we may consider that 3 tons of sun-dried Eupatorium cuttings have about the same value as 1½ cwt. cyanamide, which would cost about Rs. 10-8 to apply, so that a ton of sun-dried cuttings is worth about Rs. 3-8 including cutting, carriage, and spreading. This would make the value of a ton of undried freshly-cut material about Rs. 2, which is about the value, for mature tea, of a ton of cattle manure or good humus compost, in all cases inclusive of carriage and spreading costs.